ASSESSING THE EFFECT OF BRAIN – BASED LEARNING STRATEGIES USING ARTIFICIAL INTELLIGENCE ON MIDDLE SCHOOL STUDENTS' LEARNING ABILITY: AN EMPIRICAL INVESTIGATION OF INDIAN SCHOOLS

SYNOPSIS

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1. Title of the Proposed Research

Assessing the effect of brain – based learning strategies using Artificial Intelligence on middle school students' learning ability: an empirical investigation of Indian schools

2. Introduction

Educators and others involved in education are particularly concerned about how to get and keep students interested in schoolwork, especially during the formative years of their lives. A loss in academic interest in early years has been recognised by researchers and theorists, and for some students, this decline continues through high school or culminates in "dropping out"[1]. These teenagers may not be able to achieve their full academic capability. When it comes to improving learning experiences, educators as well as neuroscientists have concentrated their efforts in recent decades on implementing the newest insights on how the brain works, as well as how the brain stores and retrieves information. Research in the 1990s, for example, made it feasible for scientists to peer inside the brain and observe the way in which its various parts communicate with one another.

The knowledge of the way the brain performs its functions and how it affects learning has the potential to improve education. The concept of brain-based learning was born out of this knowledge of how the brain operates and how it relates to education. Using instructional tactics that are designed to work with the propensity of the brain for seeking, digesting, as well as storing information, brain-based learning is a proposition to learning and teaching wherein learner is at the core of everything that happens [2]

When it comes to teaching, [3] laid out certain principles that govern the approach and pinpointed specific variables that help students learn better.

- The mind/brain is social in nature.
- Learning is a bodily process.
- The hunt for significance is a natural instinct.
- The process of "patterning" is central to the pursuit of meaning.
- When it comes to patterning, emotions play a key role.
- The mind/brain is capable of concurrently processing both wholes and parts.
- In order to learn, it is necessary to pay attention in both a focused and unfocused manner.
- Unconscious as well as cognitive processes are involved in the process of learning.
- Learning is a process that develops through time.
- When facts and skills are encoded in the brain's inherent spatial memory, the brain recognizes and retains them.
- Challenge enhances learning, but threat inhibits it.
- The structure of each person's brain is unique.

Those who support a curriculum based on the brain contend that "brain-compatible" education is distinct from "brain-antagonistic" instruction, which can actually thwart the process of effective learning [4]. According to this theory, educating students without taking into account how the brain processes information is analogous to constructing a

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glove without considering the shape and movement of a hand. The brain as a learning organ must be understood if classrooms are to be spaces of learning.

3. Literature Review

The paper [5] throws light on the connection between learning and other cognitive processes and brain asymmetry. Language and motor control are two asymmetrical human brain functions that have been localized to the left hemisphere in about 85% of people. It suggests that the left hemisphere might be more important than the other hemisphere for language along with fine motor skill acquisition. The study finds genetic loci linked to brain asymmetry, which may also be related to neurodevelopmental disorders and educational attainment. This would imply that learning capacities and cognitive processes may be impacted by genetic factors influencing structural variability in the brain. Notion of brain dominance and its significance in the education field are discussed in paper [6], which emphasizes that understanding a student's brain dominance will help them learn much more. Their findings indicate that each person's cognitive abilities are influenced by their left brain or right brain dominance. While those having right brain dominance are good in imaginative fields like art, music, etc. the left-brain dominant person excels at analysis. Original research on the connection between brain lateralization and executive functions—specifically, monitoring abilities—was presented in the paper [7]. According to the study's findings, monitoring ability across verbal, spatial, and temporal tasks is positively correlated with right-lateralized brain mechanisms, specifically in the middle frontal gyrus (mMFG). The paper [8] explained how the right and left sides of the brain function differently, as well as their roles in learning and cognitive processes. As a result, the brain's two sides have distinct specializations. The processing of particular stimuli and learned responses has been linked to the left hemisphere; this may also play a significant role in tasks requiring logical reasoning and focused attention. The right hemisphere, on the other hand is more involved in processing a wide variety of stimuli, particularly those that involve feelings or are novel. When interacting with others and expressing strong emotions, the right hemisphere is heavily active. The study [9] investigated the ideas of brain dominance in learning, paying particular attention to personality types like introverts and extraverts and how they affect preferred learning styles. According to a study [10], boys and girls use different parts of the brain, which may result in different ways for them to process information. This highlights how brain dominance shapes educational strategies, particularly when it comes to gender differences.

It can be challenging but satisfying to strike a balance in a diverse classroom, especially when it comes to accommodating students who have left brain dominance and right brain dominance. Being a teacher, if you want to help a diverse group of students, even if they are left-, right-, or middle-brained, you should think about how they learn and their brain side. The side that is dominant will have an effect on how students should be taught [11].

It is essential to have some understanding of the relative strengths of the students' left and right brains. When a teacher has a strong understanding of the class they are instructing, they are better equipped to select appropriate approaches, tactics, and content [12].

The findings of the study [13] demonstrated a substantial connection between brain's dominant hemisphere and reading ability. In its conclusion, the study makes a number of suggestions regarding potential implications as well as potential future lines of inquiry.

"Brain-based learning" is used here to refer to a technique to education that is grounded in neuroscience and consists of a core set of twelve principles for learning gathered from a wide range of studies in the field and compiled by [3].

In their study, [14] authors provide a detailed examination of the intelligent components present in an e-learning system. These components include speech recognition, biometric identification, sentence meaning analysis, etc.

Artificial intelligence (AI) has transformed education and cognitive learning in recent years by enhancing the educational process with cutting-edge AI-powered tools [15].

According to one study [16], Artificial Intelligence (AI) is crucial for education, especially for cognitive learning through adaptive learning systems. AI-powered personalized learning has been used in the study to create learning systems that are tailored to each student's cognitive skills.

Another study highlights a number of important aspects of AI's role in education and cognitive learning. AI is predicted to drastically alter educational methods, opening up new possibilities for technological advancement and instructional design.

The study [17] highlights a number of obstacles to improving middle school students' online learning skills.

The paper [18] identifies two significant pedagogical challenges faced by the teachers of middle school when implementing a technologically-driven Problem-Based Learning (PBL) program.

The study [19] examines usage of humanoid robots in the field of education for students having intellectual disabilities, contrasting goal achievement and engagement with more conventional approaches. Results vary depending on learner characteristics, but they indicate that robots can be just as effective in providing motivation and interaction benefits.

Glimpses of Literature Review

S.No.	Study	Research Objectives	Research Methodology	Findings/ Recommendations
1	[19]	To evaluate whether humanoid robots can engage learners with intellectual disabilities in educational tasks.	1. Conducted a comparative study with students having intellectual disabilities. 2. Learners participated in both robot-led and traditional human-led teaching sessions.	1. Robots were as effective as human teachers in engaging students and supporting goal achievement. 2. AI/robot-assisted teaching should be seen as a complementary tool, not a replacement.
2.	[13]	Are brain dominance and the growth of reading and writing abilities among Malaysian university students significantly correlated?	A quantitative, correlational methodology was used in this study to determine the degree of relationship among two variables, namely brain dominance as well as two English skills, speaking and reading.	1. Researchers who are interested can carry out comparable studies using a larger sample of sophomores in different regions of the nation. They may improve the findings of the current study's generalizability. 2. Future research using a qualitative methodology may bring light on how EFL learners view the significance of brain dominance in their learning, while this study was quantitative. 3. More research is needed to look at how various teaching

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				philosophies and techniques affect the brain dominance of EFL students. more research is needed to look at how various teaching philosophies and techniques affect the brain dominance of EFL students.
3.	[12]	To determine the most dominance that students use when learning STEM. To determine whether or not STEM learning is impacted by the left and right brains.	This study is quantitative in nature and employs an ex post facto research design. It is well known that the independent variable is not treated in this design. Academic success in STEM education is the dependent variable in this study, while the students' left and right brain dominance are the independent variables.	The learning styles of the students vary depending on whether the right or left brain is dominant. This significantly affects the learning process. As a result, it is crucial that they have a sense of the students' brain dominance.

3.1 Research Gaps

- When the teachers understand how the left and right sides of the brain work, they will be ready to try new ways of teaching that will help their students. By recognising that each side of the brain is different and that people learn in different ways, and by utilising instructional strategies that incorporate both of these, each and every pupil would have an equal opportunity to learn and also acquire substantial knowledge.

- Learner's database can be created to store the interaction of the learner with the e-learning system, and Artificial Intelligence technique can be used to identify learners' performance from online interaction.

- Integration of an AI chatbot with the e-learning system will help to handle students' FAQ.

4. Research Objectives

- To determine whether a student from a CBSE school population is left-, right-, or whole-brained dominant.
- To develop a model for categorizing students as left-, right-, or whole-brained dominant and to recommend activities according to their brain dominance to enhance their dominant brain.
- To measure the effectiveness of the developed model on the students.

4.1 Hypotheses Development

H_{01}: *There is no difference in the learning of the students having Left brain dominance, students having Right brain dominance, and students having whole brain dominance when taught using Artificial Intelligence and when instructed utilising more traditional approaches such as lectures.*

5. Research Methodology

5.1. The Study- The study will be empirical in nature

5.2 Sampling Design

5.2.1. Population: The study's population will be the students of the middle classes of selected public and private CBSE schools of India.

5.2.2. Sample Size: Sample will consist of 450 students from CBSE schools of India. In order to ascertain the sample size, one might employ a sample calculation formula commonly referred to as Andrew Fisher's Formula [20].

1. Ascertain the population size (if known). In my research, the population size is unknown.
2. Calculate the interval of confidence. In my research, interval of confidence is ± 5%.
3. Calculate the level of certainty. In my research, the confidence level is 95%.
4. Calculate the standard deviation (opting for a standard deviation of 0.5 is a prudent decision when the exact value is uncertain).
5. Calculate the z-score depending on the given confidence level. For 95% confidence level, z-score is 1.96.

Formula to calculate sample size = $\frac{(\text{z-score})^2 * \text{std_dev} * (1 - \text{std_dev})}{(\text{confidence interval})^2}$

$$= \frac{(1.96)^2 * 0.5 * (1 - 0.5)}{(0.05)^2}$$

$$= \frac{3.8416 * 0.5 * 0.5}{0.0025}$$

$$= \frac{3.8416 * 0.25}{0.0025}$$

$$= \frac{0.9604}{0.0025}$$

$$= 384.16$$

Based on the computation provided, a sample size of around 385 is deemed adequate for making inferences about populations of various sizes with a confidence level of 95% and a 5% margin of error. This is why researchers commonly employ sample sizes of 400 and 500. So, I have taken a sample size of 450 students.

5.2.3 Sample Element: The distinct students act as the sampling element.

5.2.4 Sampling Technique: Purposive and Convenience sampling methods will be utilized for data collection

5.3 Instruments for Data Collection

- Brain Dominance Test and marks of the students will be utilized for collecting data.

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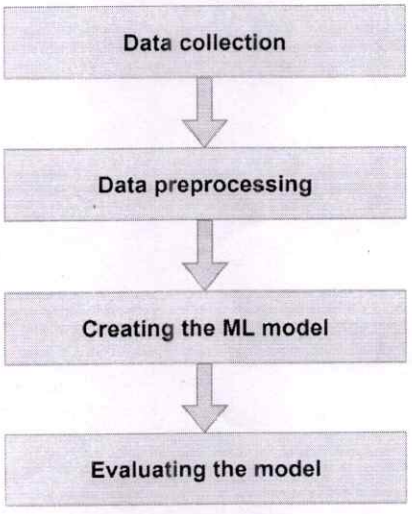
- **Web Chatbot Interface**
  - A single-screen full-page web chatbot interface will be developed where the students can interact.
- **Initial Questions and Data Storage**
  - The initial set of questions that the chatbot will ask the student will be designed and implemented.
  - All responses will be collected and stored in a CSV file.
- **ML Model Integration**
  - ML classification model will be developed and integrated using the secondary data, and the data provided by the student will be used to predict whether the student is left-, right-, or whole-brained dominant.
- **Display Predefined Text**
  - Based on the classification result (left-, right-, or whole-brained dominant), a predefined set of text with activities specific to that category will be displayed.
- **Questionnaire Flow**
  - The flow of questions (images) appearing for the student to answer will be implemented.
  - Each question will have a fixed answer.
  - Three levels of questions (basic, intermediary, advanced), each containing 50 questions, will be added in the chatbot.
  - The level increases as the student progresses.
- **Score Calculation**
  - At the end of the exercises, the final score based on the correct answers given by the student will be calculated using the answer key and displayed to the student.

Brain dominance varies based on the learner. It is a dynamic aspect of learning, and difficult to forecast the learner's exact brain dominance. To address this inaccurate difficulty, a machine learning model is being created on the basis of secondary data. Data is collected from the questionnaire, and their score is calculated to identify the learner's brain dominance.

The following figure shows a proposed model of a Machine Learning Model for brain dominance analysis.



Brain Dominance is classified as left-, right-, or whole-brained dominance.

1. **Data Collection** – The Open Hemispheric Brain Dominance Scale test will be administered to the participants. The participants will do the tests. Scoring of the tests will be done according to the scoring method given in the tests. The scores will be stored in a .csv file.
2. **Data Preprocessing** – The data will be extracted from the .csv file. The data will be cleaned and preprocessed.
3. **Machine Learning model** – A machine learning model will be made based on secondary data.
4. **Evaluating the model** – The model will be evaluated for accuracy.

Better learning satisfaction results from the recommendation of a learning route and appropriate material for the individual learner based on their learning needs and interests. The dynamic, personalized learning system is created by tailoring the learning path to the individual learner's brain dominance. An integrated Chatbot will be created using Artificial Intelligence, which will predict the dominance and recommend left-brain-related activities to left-brain dominant learners, right-brain-related activities to right-brain dominant learners, and whole-brain dominance activities to whole-brain dominant learners.

Learning route optimization in a learning system means choosing a series of learning items to increase a student's dominant brain's characteristics. It entails determining brain dominance and then organizing learning content based on the learner's dominance result.

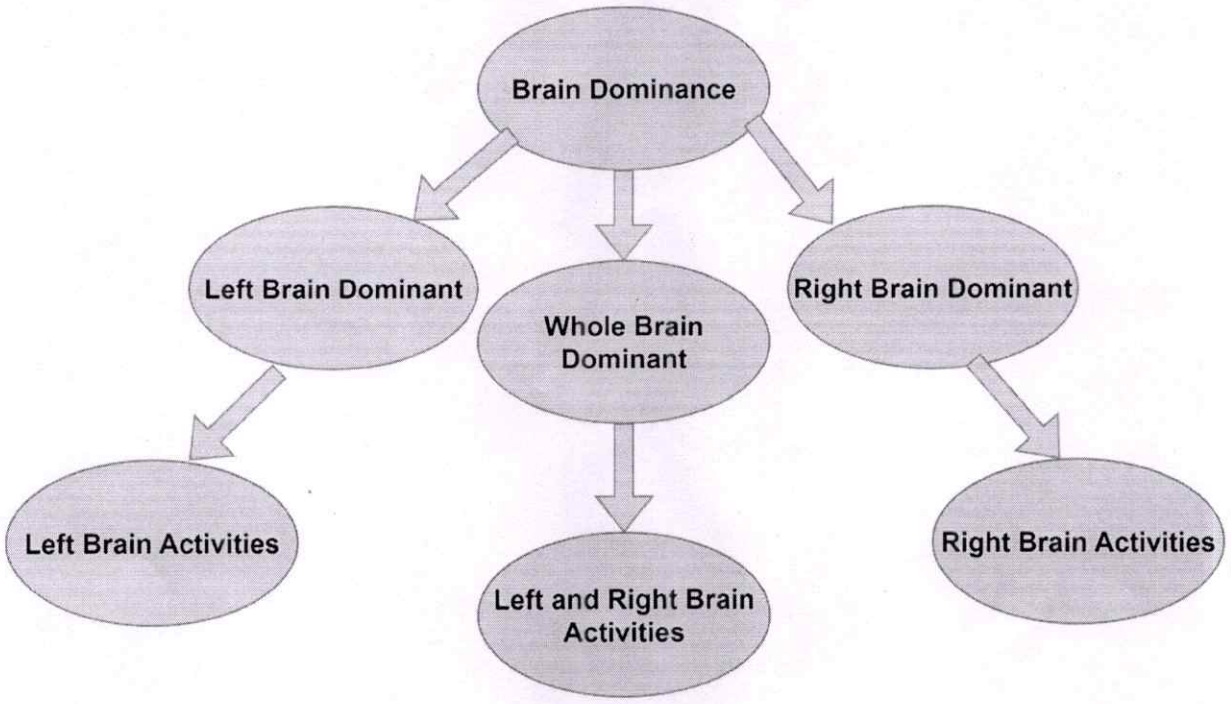
All learners must complete stepwise activities in the sequential learning route. After finishing the first task, the procedure will continue until the last activity is completed.

Individual learners are classified as left-, right-, or whole-brained dominant. Depending on their brain dominance, learners are assigned to individual learning paths.

In a personalized e-learning system, the following step-by-step approach is used to determine the learner's learning path:

1. The system recommends left-brain enhancement activities to the learner if the student is left-brain dominant.
2. The system recommends right-brain enhancement activities to the learner if the student is right-brain dominant.
3. The system recommends left-brain and right-brain enhancement activities to the learner if the student has whole-brain dominance.

Figure shows the learning path for learning system



5.4 Tools for Data Analysis

The collected data will be evaluated through descriptive and inferential statistical instruments. Primary data analysis software like MS EXCEL, IBM SPSS or SMART PLS.

6. Expected outcomes of the proposed study

The proposed research will have a noteworthy contribution in refining the learning ability of students for assessing the total impact of Artificial Intelligence on the left-brain dominant students, right-brain dominant students and whole-brain dominant students of India. Since the students in India are not primarily unlike from the students of developed countries, therefore, the proposed study will be helpful to various stakeholders from all over the world.

The educational institutions will take the advantage of this study and might use in teaching the students. The academician will gain advantages in teaching relatively new area of study by which they may develop some case studies and have insights in this emerging area to strengthen their students' competence. The proposed research will also have future directions for upcoming researchers where they can add some more constructs to have better understanding.

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